Structure, change over time, and outcomes of research collaboration networks: The case of GRAND

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Jan. 14th, 2015

Some assembly required

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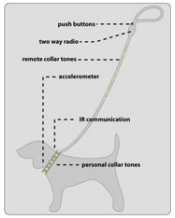
SNIF social networks for dog owning shut-ins

by Ryan Block | | March 23rd 2005 at 9:56 am

Maybe it's just us, but it appears when walking your dog around the streets of Manhattan, all you do is meet other dogs (and, of course, their people). But if you're like the boys at MIT's Physical Language Workstop (uh... ?), obsessively keeping track of every single interaction your dog makes with others of its kind should be in the cards—so long as they're wear SNIF collars, which wirelessly record canine social network IDs of other poochies in close range, you'll never again lose track of which dog's butt Rover thinks smells the best (or much in the same vein, which dog's owner you meant to flirt with but didn't get the chance). [Warning, PDF link!]



[Via Near Near Future]

COMMENTS DISABLED

PREOCCUPATIONS

Building the Team That Built Watson

Ozier Muhammad/The New York Times

David Ferrucci led the team behind Watson, the victorious "Jeopardy" computer. "For the scientist in me," he says, "it was an irresistible challenge.".

By DAVID A. FERRUCCI
Published: January 7, 2012

THE assignment was one of the biggest challenges in the field of artificial intelligence: build a computer smart enough to beat grand champions at the game of "Jeopardy."

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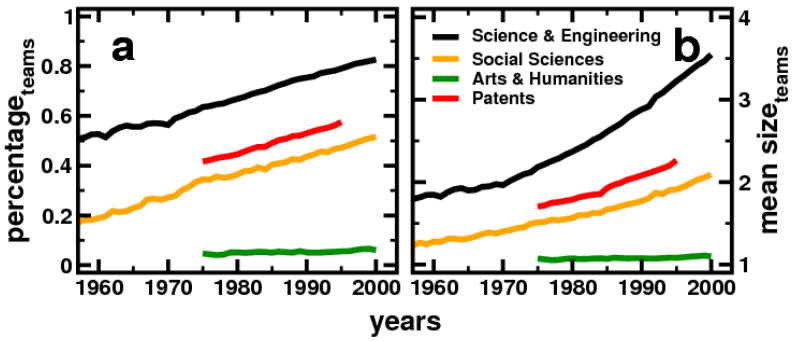
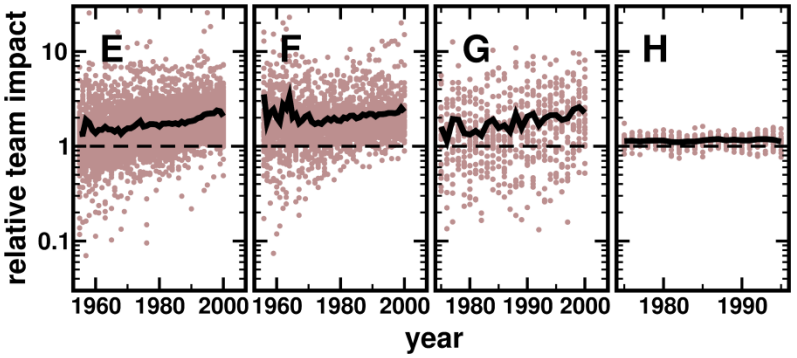
Move to collaborative research

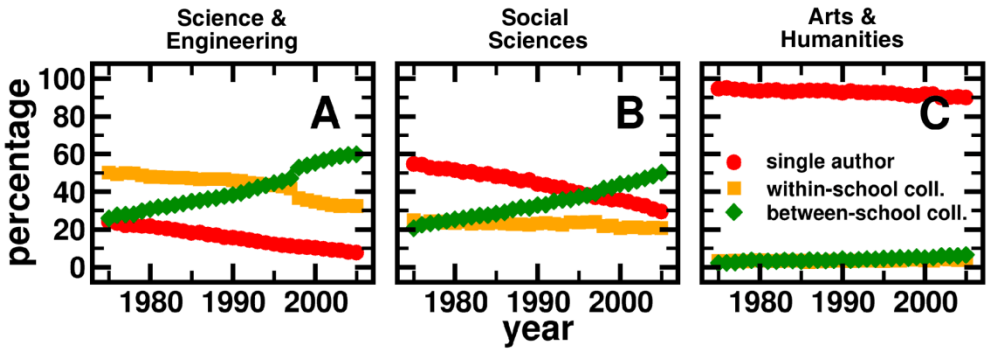
- Wuchty, Jones, Uzzi and (2007) Studied 19.9 million research articles over 5 decades as recorded in the Web of Science database, and an additional 2.1 million patent records from 1975-2005 and found three important facts.
  - For virtually all fields, research is increasingly done more collaboratively.
  - Collaboratively research produce more highly cited research than individuals do, and this pattern increase over time.





Move to collaborative science

- Cummings and Kiesler conducted an evaluation study of research collaborations supported by the National Science Foundation (2005).
- Their finding indicates that large geographically dispersed projects reported fewer positive outcomes than those of smaller collocated projects it terms of:
  - New ideas
  - New tools
  - Career development
  - Project outreach

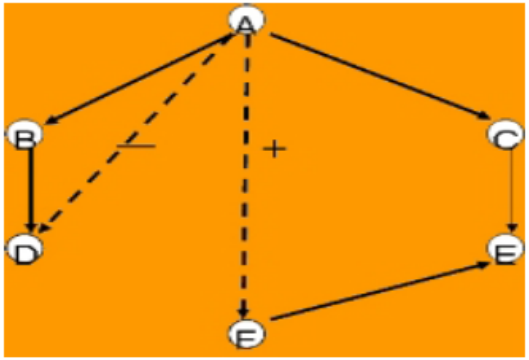


Multi-theoretical models for the assembly of teams

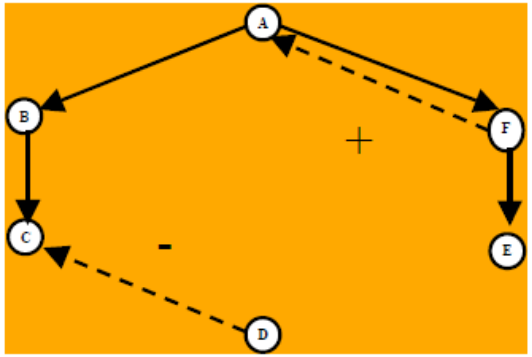
- Theories of self-interest
- Theories of social and resource exchange
- Theories of mutual interest and collective action
- Theories of contagion
- Theories of balance
- Theories of homophily
- Theories of proximity

Source: Contractor, N. S., Wasserman, S. & Faust, K. .(2006). Testing multi-theoretical multilevel hypotheses about organizational networks: An analytic framework and empirical example. *Academy of Management Review.*

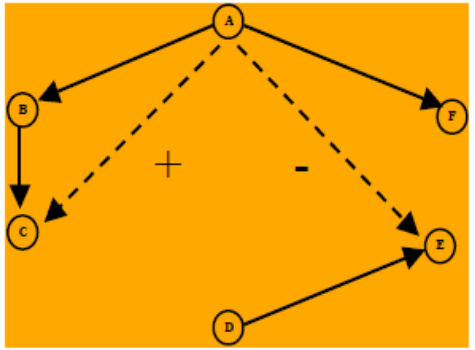
Structural signatures



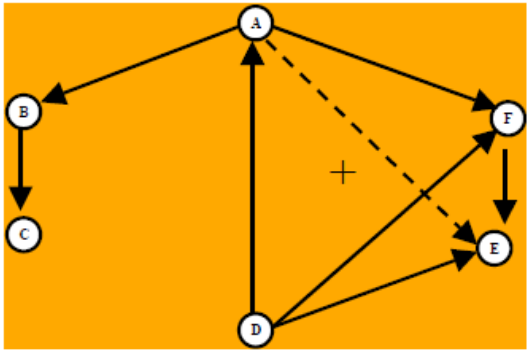
Theories of Self interest



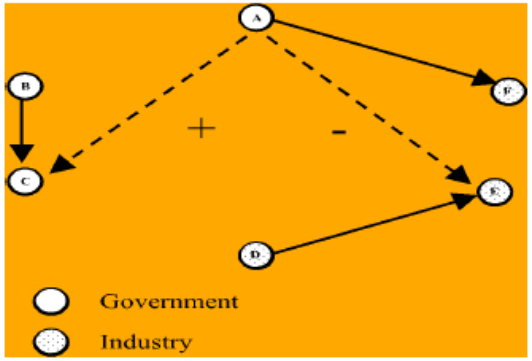
Theories of Exchange



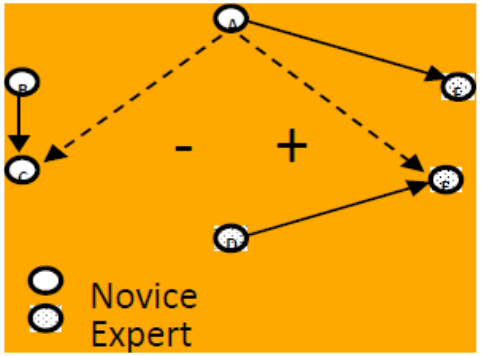
Theories of Balance



Theories of Collective Action



Theories of Homophily



Theories of Cognition

- Challenges of **empirically** testing, extending, and exploring theories about assembly of teams ...

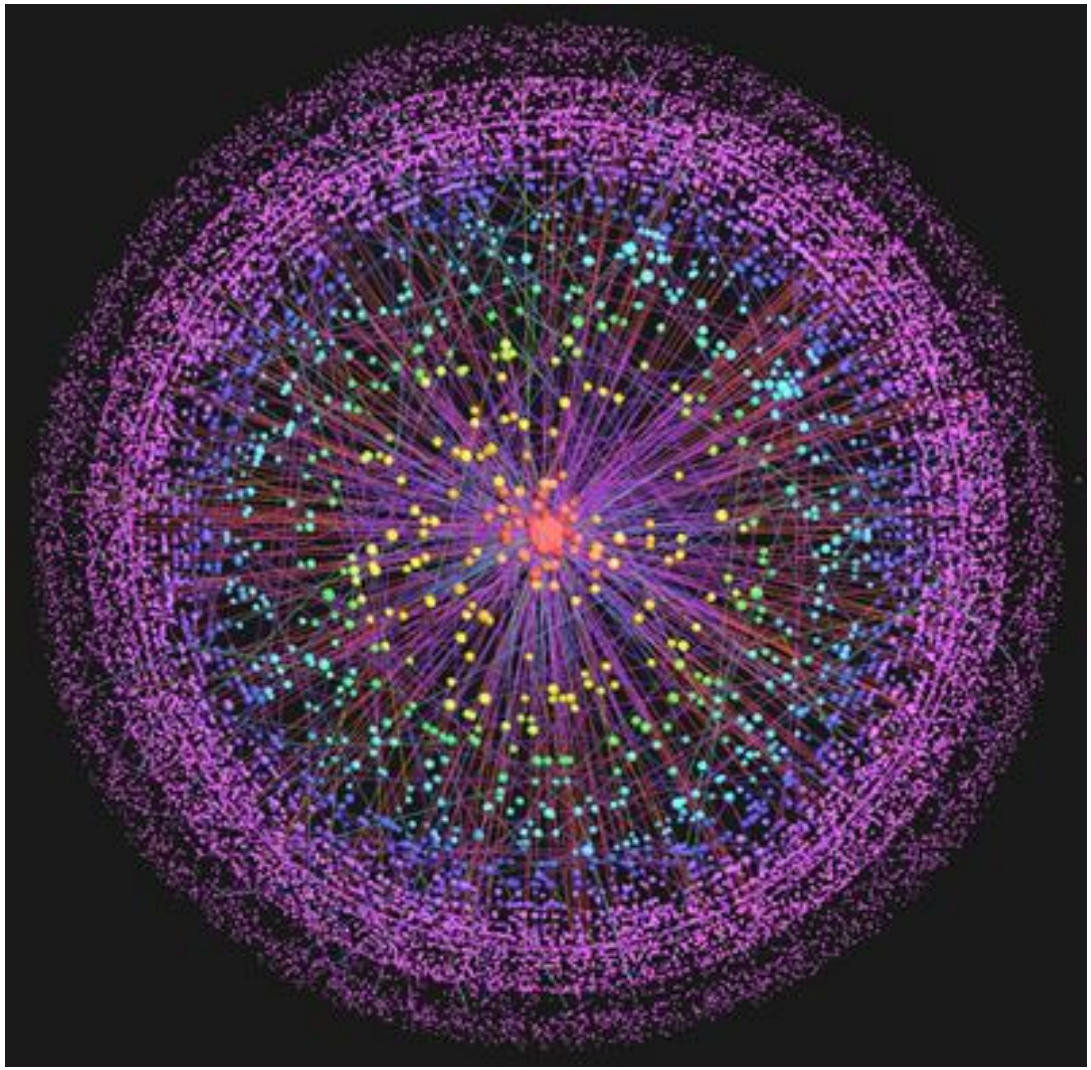
The Hubble telescope: 2.5$ billion

Source: David Lazer

CERN particle accelerator: 1$ billion/year

Source: David Lazer

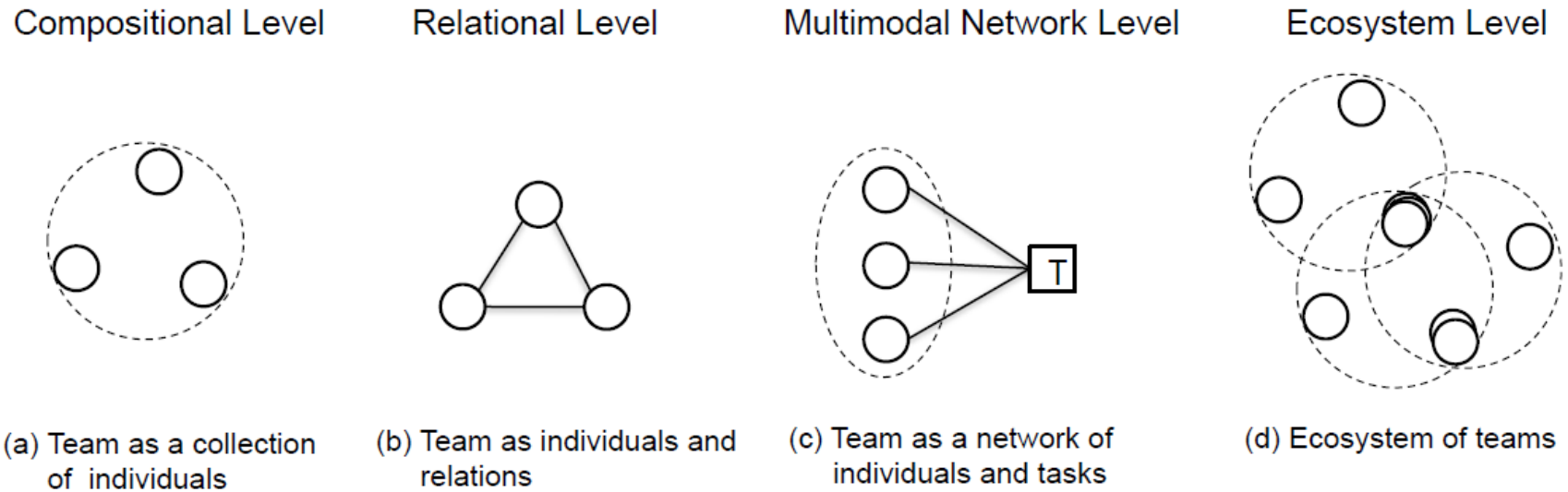
The Web: priceless



Source: David Lazer

** Apologies to MasterCard*

Four levels of influences on team assembly



Source: Contractor, N. S., Wasserman, S. & Faust, K. .(2006). Testing multi-theoretical multilevel hypotheses about organizational networks: An analytic framework and empirical example. *Academy of Management Review.*

Literature review: rresearch collaboration

- Defining research collaboration
  - Research collaboration is a social process, taking place in a social context, in which researchers interact to share meaning, develop understanding, and perform tasks to achieve a mutually shared superordinate goal, which generally produces knowledge (Sonnenwald, 2007).
  - Social (as evinced by researchers' social ties and communication patterns) and epistemic dimensions (indicated by the production of research outputs around the same research topics)

Research collaboration

- Research outcomes adapted from Cummings and Kiesler (2005)

Research Outcomes	Items Used for Measurement
Knowledge Outcomes	Started new field or area of research; developed new model or approach in field; came up with new grant or spin-off project; submitted patent application; presented at conference or workshop; published article(s), book(s), or proceeding(s); was recognized with award(s) for contribution to field(s).
Training Outcomes	Grad student finished thesis or dissertation; grad student/post-doc got academic job; grad student/post-doc got industry job; undergrad/grad student(s) received training; undergrad(s) went to grad school.
Outreach Outcomes	Formed partnership with industry; formed community relationship through research; formed collaboration with researchers; established collaboration with high school or elementary school students; established collaboration with museum or community institution; established collaboration with healthcare institution.
Collaboration Outcomes	Started with people in your project team collaborations that will continue beyond that scope. Started collaborating with people who are not members of my project, and this collaboration will continue in the future. Shared data with other research projects.

- Social capital
  - In its simplest form, social capital can be defined as the social networks or connections through which one gains access to resources (Bourdieu, 1986).
  - For the purpose of this study, social capital theory is defined as the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual.

Dimensions of social capital

- Nahapiet & Ghoshal (1998) proposed three main dimensions for the study of social capital:
  - Structural i.e., overall patterns of ties among the researchers
  - Relational i.e., the kind of personal relationships researchers have developed with each other through a history of interactions
  - Cognitive i.e., resources which are providing shared representations, interpretations, and systems of meaning among researchers.

- This widely used conceptualization has been adopted for the study of social capital within research networks (Trier & Molka-Danielsen, 2013).

Research questions

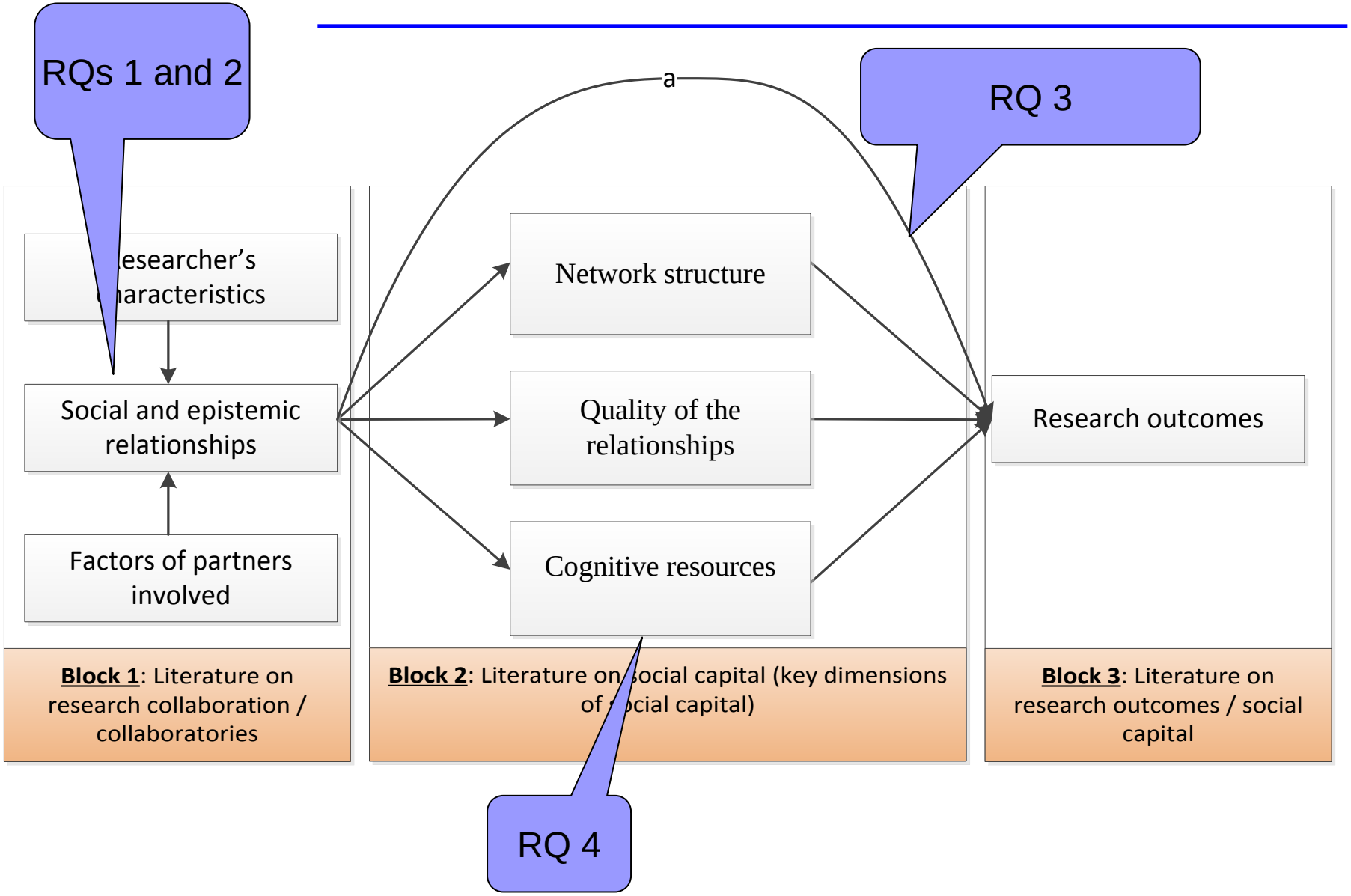
- Studying research networks
  - RQ #1. Which types of structures can be detected in the co-authorship, communication, acquaintanceship, and advice exchange networks of GRAND researchers?

- Stages of research collaboration
  - RQ#2. What collaboration changes can be evinced from the co-authorship, communication, acquaintanceship, and advice exchange networks of GRAND researchers?

Research questions

- Research collaboration and research outcomes
  - RQ3: How do the structural features of the co-authorship, communication, acquaintanceship, and advice exchange networks of GRAND researchers, and the change of these features over time interplay with the researchers' research outcomes?
- Social capital and social network analysis
  - RQ #4: In what manner can the social capital literature can help in interpreting the way structural features of the co-authorship, communication, acquaintanceship, and advice exchange networks of GRAND researchers, and the changes of these features over time interplay with the researchers' research outcomes?

Literature review summary and research questions

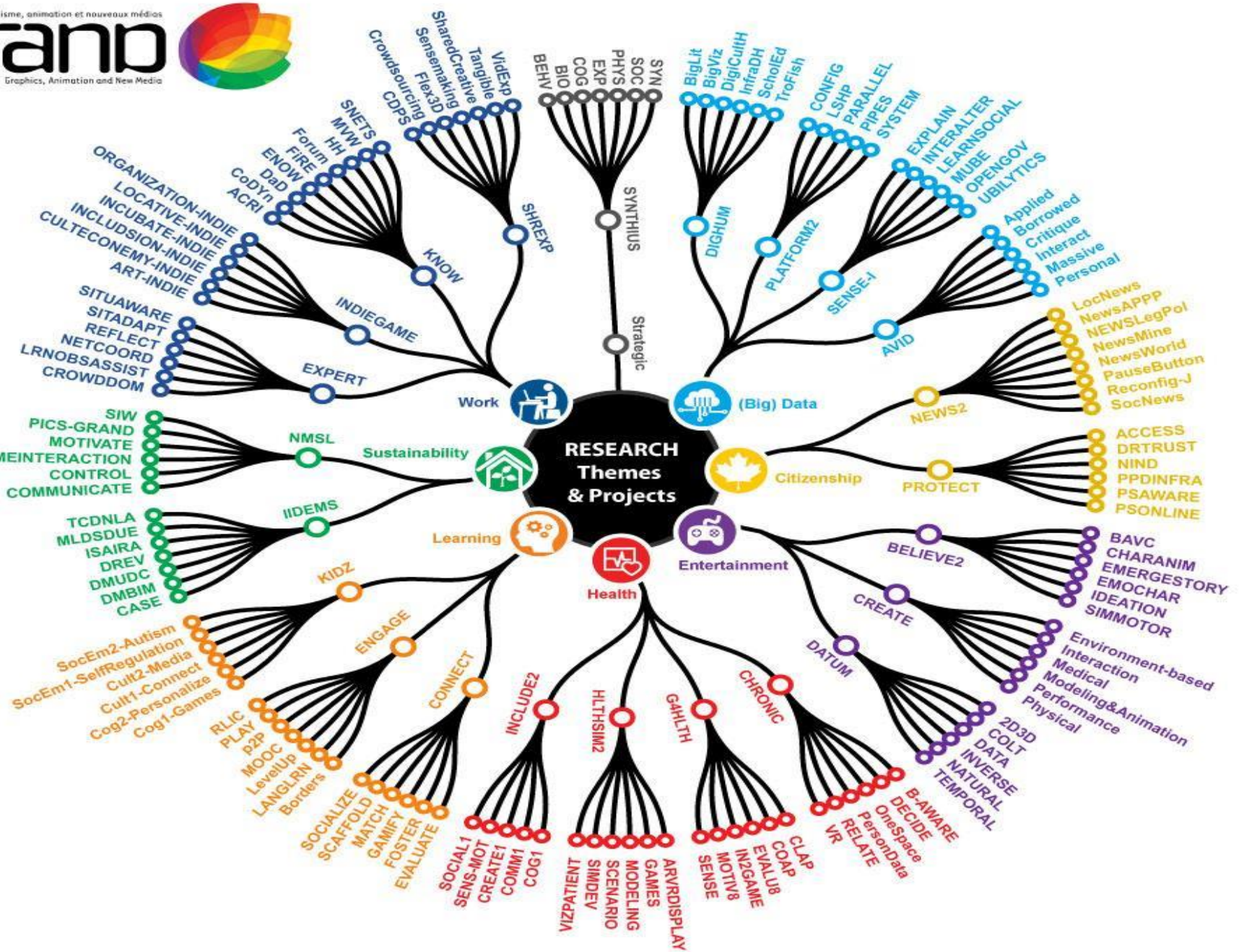


The GRAND case study

Graphisme, animation et nouveaux médias

grand

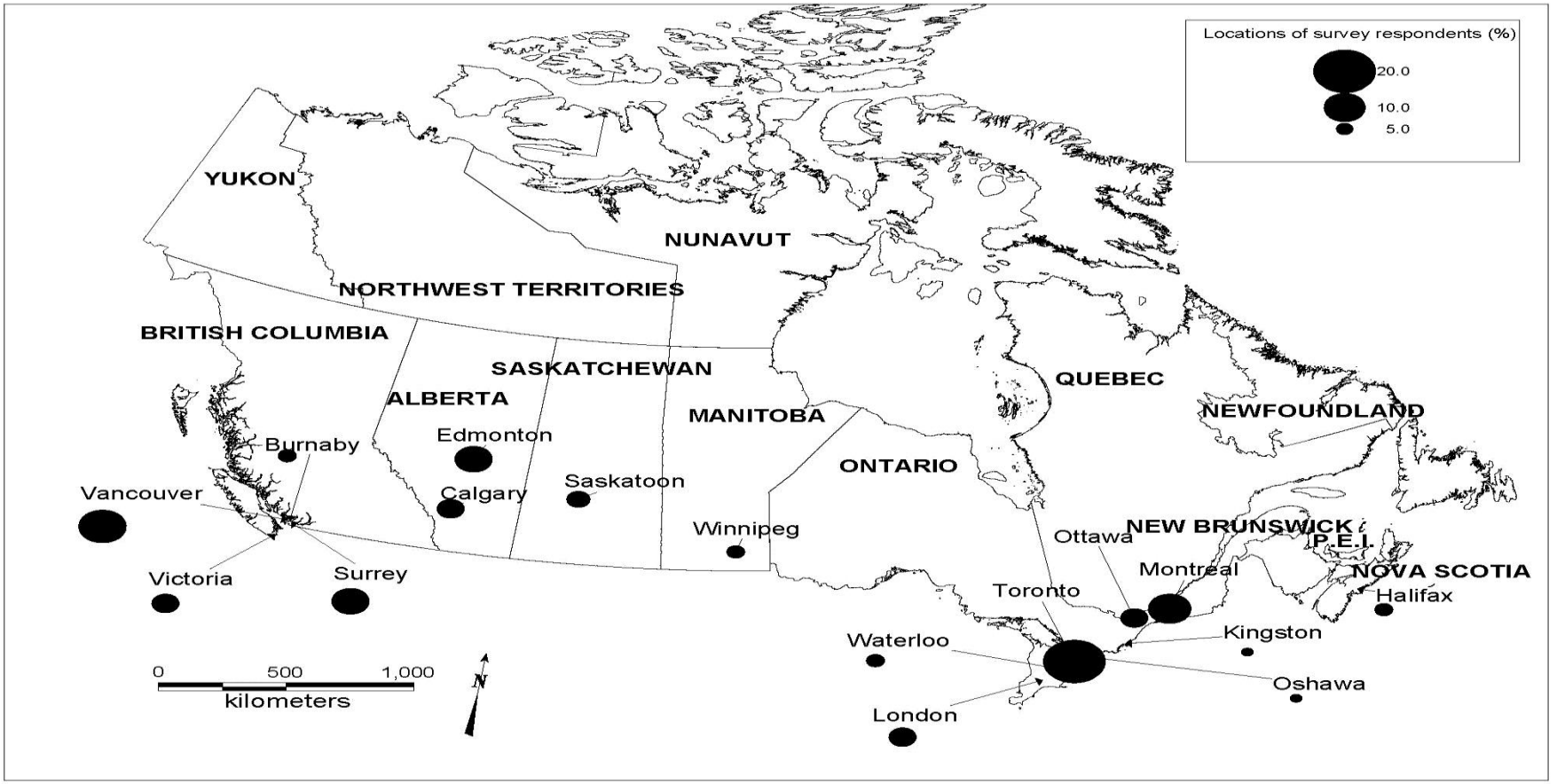
Graphics, Animation and New Media



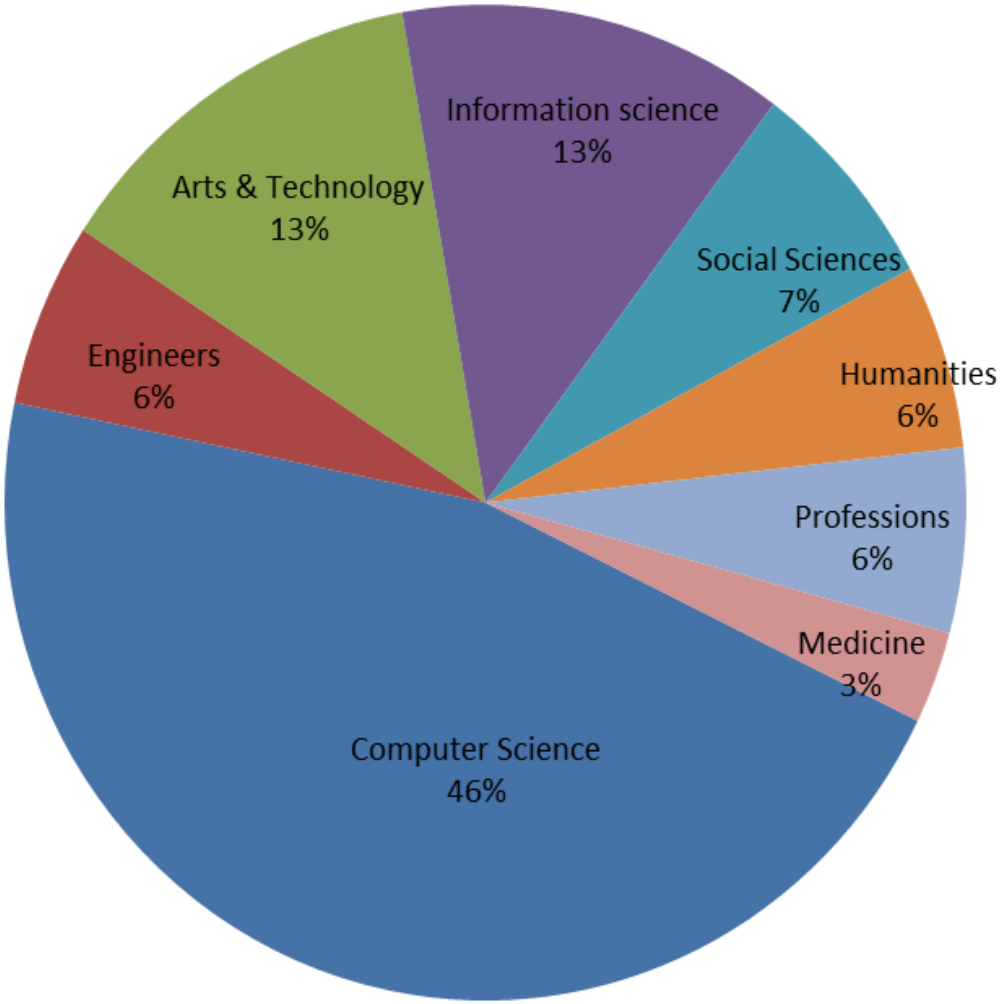
The GRAND Case Study

- An NCE – “Network of Centres of Excellence”
- GRAND = GRaphics Animation New Media Design
- Over 200 researchers, affiliated with 26 institutions across Canada, and working on 34 different research projects.
- Every project must contain 3+ researchers at 3+ Universities

The GRAND Case Study



The GRAND case study



Grand as a case study

- GRAND features a headquarter base located at Vancouver, BC, yet GRAND-related work is conducted at all 26 member institutions.
  - preventing continuous physical interactions among scientists
- The type of research conducted at GRAN spans a wide spectrum of disciplines and applications requiring continuous cooperation among individuals

Method, Data, and Instruments

- Mixed method: sequential explanatory design
- Communication, acquaintanceship, and advice exchange networks (social network survey instrument , two waves: the first between September and November, 2010; the second between September 2012 and March 2013)
- Co-authorship network (GRAND annual report)
- Research outcomes (paper-based outcome survey that was distributed during May 2013)
  - N=101
- Semi structured interviews (N=50)

We're surveying all faculty
using LimeSurvey (open source):
It has conditional Qs, templates;
management; but node size constraints

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NAVEL

0% 100%

YOUR GRAND NETWORK

In this section, we ask you about who you know among the people involved in GRAND.

It does not matter how well you know these people. By **"know"** we mean you have talked at conferences or meetings, discussed professional or personal matters, or worked together on a project or a publication in the past 12 months.

Your interaction with them does not necessarily have to be related to the work of GRAND. For instance, you might have met a participant in GRAND because you both sit on a government advisory board or on a student thesis committee. This person is a member of your network.

Below is a list of participants in GRAND, grouped by organization. Please check the boxes next to the names of the people you know.

Carleton University

- [ ] Biddle, Robert
- [ ] Greenspan, Brian
- [ ] Herdman, Chris
- [x] Mould, David
- [ ] Wainer, Gabriel

Concordia University

- [ ] Camlot, Jason
- [ ] Hughes, Lynn

YOUR PROFESSIONAL NETWORK

Our next questions are about the people in GRAND who you not only know -- but with whom you also work, exchange advice and ideas, or network. They are part of your professional network. Not all the people you know in GRAND will be also members of your professional network. Leave the boxes unchecked if you only met someone at a conference but do not collaborate, exchange advice, or network with this person.

Your interactions with the members of your **professional network** do not have to be necessarily related to GRAND. For instance, you might work with a participant in GRAND on a project outside GRAND. This person is a member of your professional network.

The table below includes the participants in GRAND you told us you know. Please check the boxes for EACH person

- **WITH WHOM YOU HAVE WORKED** on media and technology issues in the past 12 months -- such as collaborated on a research project, consulted, or wrote a paper

Over the years, collaborators often become friends or friends become collaborators. Please use the second column to tell us, for EACH person, if they are a friend.

- **WHO IS A FRIEND**

Carleton University	I WORKED with	I consider a FRIEND
Mould, David	☐	☐

Dalhousie University	I WORKED with	I consider a FRIEND
Toms, Elaine	☐	☐

University of Victoria	I WORKED with	I consider a FRIEND
Gooch, Amy	☐	☐
Gooch, Bruce	☐	☐

University of Western Ontario	I WORKED with	I consider a FRIEND
Mok, Diana	☐	☐
Peters, Terry	☐	☐

York University

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Once people are selected as network members, subsequent questions focus only on them

Variables Eexamined in This Study

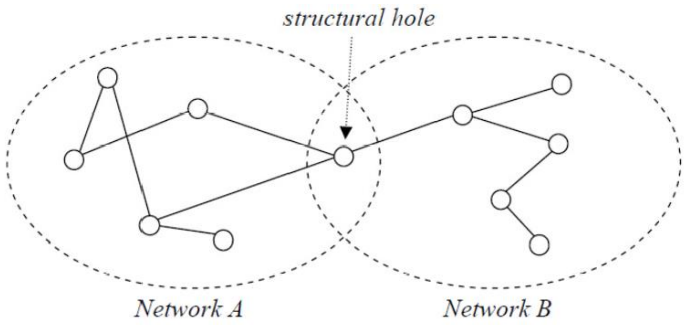
- **Ego level**:
  - Size / degree
  - Betweenness
  - Eigenvector
  - Heterogeneity
  - Effective Size
  - Density
- **Outcomes**:
  - Knowledge
  - Training
  - Outreach
  - Collaboration
- **Control variables**:
  - Age
  - Gender
  - Professional experience
  - Seniority
  - Discipline

Centrality measures

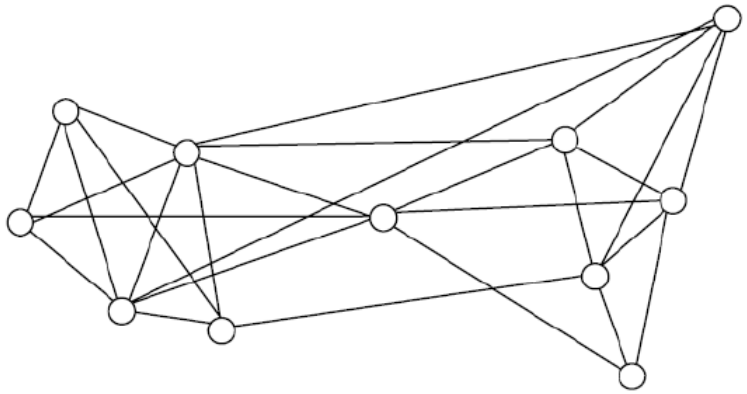
Description	Relation to Social Capital	Name
The number of alters that an ego is directly connected to, weighted by strength of tie.	Positive. The more people you have relationships with, the greater the chance that one of them has the resource you need.	Size / degree (Burt, 1983)
The number of times that ego falls along the shortest path between two other actors.	Positive. Actors with high betweenness link together actors who are otherwise unconnected, creating opportunities for exploitation of information & control benefits.	Betweenness (Freeman 1979)
The extent to which ego is connected to nodes who are themselves high in eigenvector centrality.	Positive. An actor has high eigenvector scores when they are connected to well connected others.	Eigenvector (Bonacich 1972)
The variety of alters with respect to relevant dimensions (e.g., sex, age, occupation, talents).	Positive (except when it conflicts with compositional quality)	Heterogeneity (Burt, 1983) (Requires attribute data on all nodes in addition to relational data).
The number of alters, weighted by strength of tie, that an ego is directly connected to, minus a "redundancy" factor.	Positive. The more different regions of the network an actor has ties with, the greater the potential information and control benefits.	Effective Size (Burt 1992)
The proportion of pairs of alters that are connected.	Positive. The ego and alters are more tightly bound by a level of trust, which leads to the assumption that members of the group will help each other by sharing knowledge and resources. **(Mutual trust)**	Density (Coleman, 1988)

Literature Review: Social capital and Social network analysis

- The structural hole theory

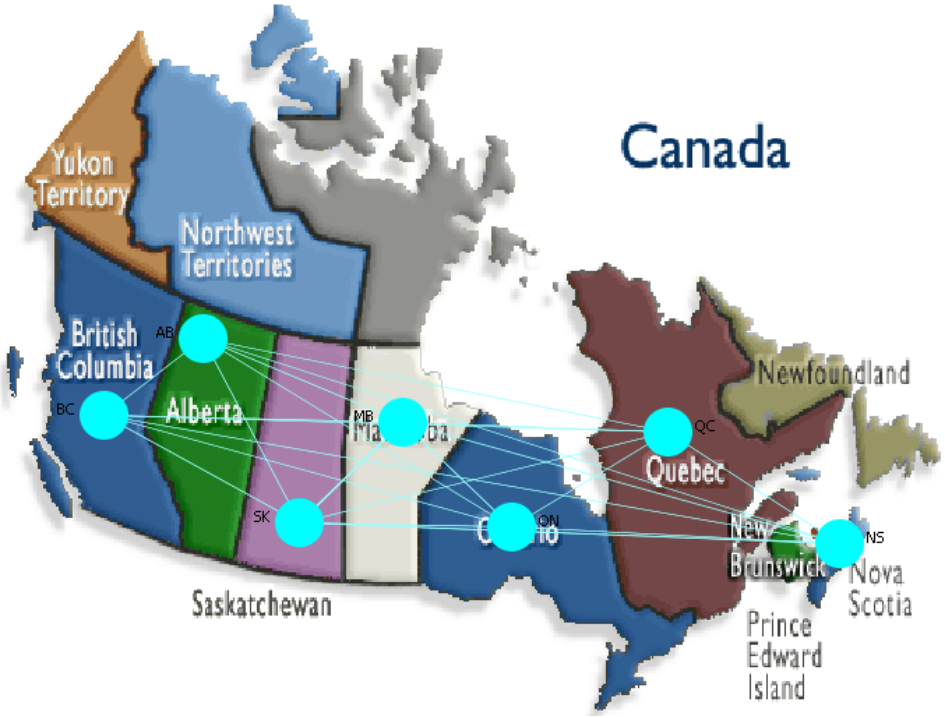


- The social closure theory

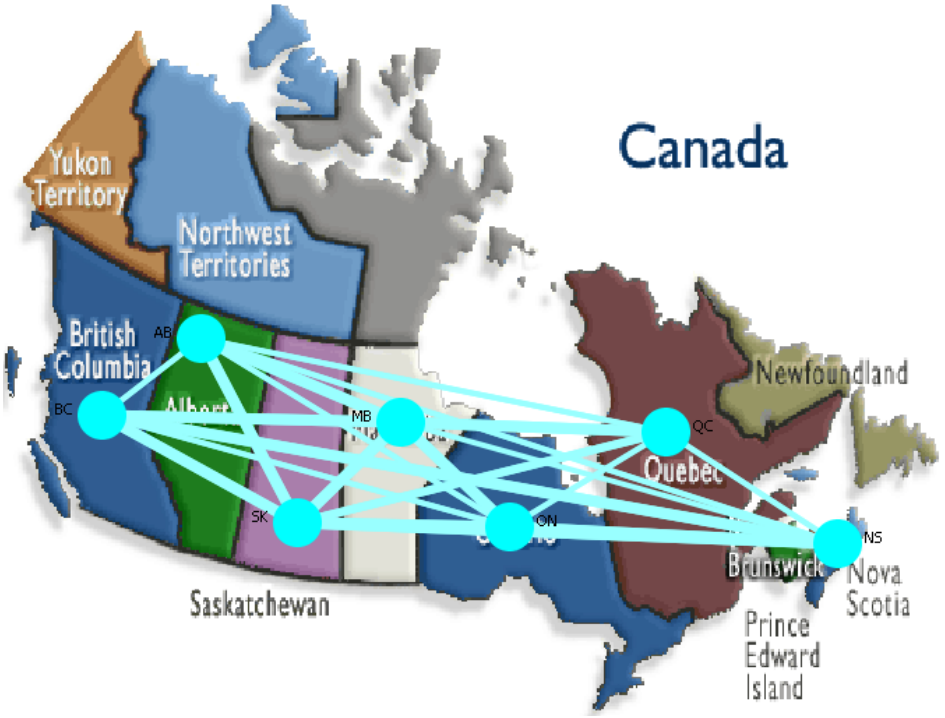


Positioning research networks between Structural Holes and Social Closure

Growth of acquaintance network across distance



2010



2013

32

Research outcomes

Model 1: Knowledge Outcomes		**Model 2: Training Outcomes**		**Model 3: Outreach Outcomes**		**Model 4: Collaboration Outcomes**	
Density of co-authorship ego-network	.40**	Degree centrality of advice ego-network	.24**	Effective Size of Acquaintance s-hip ego-network	.38**	Degree centrality of advice Ego-network	.26**
Betweenness centrality of advice ego-network	.35**	Effective size of co-authorship ego- network	-.19**	Effective Size of advice ego-network	.31**	Degree centrality of co-authorship ego-network	.25**
Degree centrality of co-authorship ego-network	-.04**	Density of advice ego-network	.42**	Degree centrality of co-authorship ego-network	.24*	Density co-authorship ego-network	.13*
Heterogeneity of advice ego-network	.24*	Density of communication ego-network	.39*	Eigenvector centrality of co-authorship ego-network	.19*		
Effective Size of advice ego-network	.08*						
R square: .47		R square: .38		R square: .47		R square: .33	

RQ#3: Research outcomes: knowledge outcomes

Model 1: Knowledge outcomes	
Density of co-authorship ego-network	.40**
Betweenness centrality of advice ego-network	.35**
Degree centrality of co-authorship ego-network	-.04**
Heterogeneity of advice ego-network	.24*
Effective Size of advice ego-network	.08*
	R square: .47

Note: Values in table are beta coefficients. Statistical significance is indicated by : * $p < .05$; ** $p < .01$.

RQ#4: Network Structures and Social Capital

Nodes

Name	Description
GRAND researchers characteristics	Characteristics of GRAND researchers
Other	
Research outcomes	Research outcomes of GRAND researchers
Social capital dimensions	Nahapiet & Ghoshal (1998) proposed dimensions for the study of sc
The cognitive dimension	The resources providing shared representations, interpretations, an
The relational dimension	The kind of personal relationships researchers have developed with
The structural dimension	The overall patterns of ties among the actors (i.e. the network struct
Brokerage and structural holes	A position between dense regions of relationships, within GRAND, t
Closure	The completeness of ties among the resaerchers
Heterogeneity and Homogeneity	The diversity of the disciplinary background of connected researche
Large network focus	Loose and large network of ties with other researchers in GRAND
Ties to well connected researchers	Ties to well connected researchers
Social networks	GRAND researcher's social networks

Predetermined Themes	Themes Generated Through an Examination of the Analyzed Data
The structural dimension of social capital	• Ties to well connected researchers • Lose large network • Heterogeneity and Homogeneity • Closure • Brokerage and structural holes
The relational dimension of social capital	• Trust • Norms • Closeness
The cognitive dimension of social capital	• Shared Language • Attention and time

	Model 1: Knowledge outcomes	Model 3: Outreach outcomes	Model 4: Collaboration outcomes
Degree centrality of co-authorship ego-network	-.04**	.24*	.25**

Interviews derived insights

- Researchers must reach a balance between using their own personal resources to maintain relationships with their co-authors and putting those resources towards their actual research.
- Smaller groups of collaborators are better able to support genuine collaboration and new knowledge creation.
- Larger groups provide increased opportunities for individual learning, smaller groups have a higher tendency toward the generation of new knowledge.

Contribution

- Offer a topological and structural configuration of GRAND researchers collaboration patterns
- Framework for a longitudinal evaluation of research networks
- Analysis of the organization and function of GRAND in relation to previous research on similar networks

Contribution

- Bridging social networks analysis and social capital
- Different research outcomes and different network structures
  - Theoretical implications
  - Practical implications

Future work

- Looking at emerging scientific fields
  - Dataset of 22 million PubMed papers
- Examining the teams that are publishing the first papers in these fields
- Looking at diversity along the following dimensions:
  - cognitive
  - ethnicity
  - country
  - gender

Extra Slides

Practical Implications

- Evaluation of proposals submitted to funding agencies (Hayat & Mo, Forthcoming)
  - Past work with social scientists
  - Structure of past networks
- Interventions by the research network administration (Hayat & Lyons, 2010)
  - Matchmaking
  - Bringing together students
- Measuring different types of collaboration outcomes (e.g. advice)

The Current Knowledge Gap

- Little is known about the structure, and evolution of research collaboration networks; and its interplay with research outcomes.

- Quantitative research on remote research collaboration is often performed on large, but homogeneous networks, constructed from domain-based bibliographic repositories and well-defined social circles.

  - Not taking into account the growing body of cross-disciplinary collaboration

  - Relying largely on unobtrusive data collection

The Context of Research Collaboration

- Research collaboration occurs within the larger social context of research work.
  - peer review, reward systems, invisible colleges, scientific paradigms, national and international, science policies, as well as disciplinary and university norms (Crane, 1972; Kuhn, 1970; Latour, 1987).

- It imposes constraints and enables possibilities not always found in other types of contexts, such as the service industry.

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